<u>These following Tables are for Hazard Report AMS-02-1, 3, & 5.</u>

Table A1: USS-02, Cryomagnet, and Pressure Systems Factors of Safety

Item	Sub Component	Load Case	Factor of Safety		Proof Factor	Reference	Event	Comments
			Ultimate	Yield				
Magnet Vacuum Vessel	Inner Cylinder	External Pressure	1.5*MDP	1.10*MDP	1.0*MDP	MIL-STD-1522 A (Space Shuttle)	Liftoff/Landing Ground Ops	Negative delta press. Produces burst on inner cylinder
			2.0*DP	1.10*DP	1.0*DP	SSP 30559 B (ISS)	On Orbit	DP is Max. delta press On-Orbit
		Mechanical Loads	1.4	1.10	1.10	NSTS14046 E (Space Shuttle)	Liftoff/Landing Ground Ops	
			1.5	1.10		SSP 30559 B (ISS)	On Orbit	
		Ext. pressure+ Mech. loads	1.4*(M)-min. P	1.10*(M)-min. P	1.10*M 1.0*P	NSTS14046 E	Liftoff	Liftoff mech. Loads (M) & Min. delta Pressure (P)
			1.4*(M)-min. P	1.10*(M)-min. P	1.10*M 1.0*P	NSTS14046 E	Landing	-Emergency Landing mech. Loads (M) & Min. delta pressure (P) -Normal landing TBD depending on whether Helium is present or not
			1.5(M)-min.P	1.1(M)-min. P		SSP 30559 B (ISS)	On Orbit	On Orbit mech. Loads (M) & Min. delta pressure (P)
		Internal pressure	1.10*MDP		1.0*MDP		Helium leak inside vacuum case (Failure case)	Positive delta pressure produces buckling of inner cylinder

Notes:
1) MDP Highest pressure defined by max. relief pressure (Burst discs) at 0.8 atm.(11.76 psi)
2) Reference Appendix C for failure scenarios and credibility of failures. Note: No credible failure can be found that would create a positive pressure inside the VC
3) The internal pressure case is critical design case for buckling of the inner cylinder and the conical flanges.
4) Positive delta pressure is defined as the delta pressure when the pressure inside the vacuum case is higher than the outside pressure.

Table A1: USS-02, Cryomagnet, and Pressure Systems Factors of Safety (Cont.)

Item	Sub Component	Load Case	Factor of Safety		Proof Factor	Reference	Event	Comments
			Ultimate	Yield				
Magnet Vacuum Vessel	Outer Cylinder	External Pressure	1.5*MDP	1.10*MDP	1.0*MDP	MIL-STD-1522 A (Space Shuttle)	Liftoff/Landing Ground Ops	Negative delta press. Collapses Outer Cylinder
			2.0*DP	1.10*DP	1.5*DP	SSP 30559 B (ISS)	On Orbit	DP is Max. delta press On-Orbit
		Mechanical Loads	1.4	1.10	1.10	NSTS14046 E (Space Shuttle)	Liftoff/Landing	
			1.5	1.10		SSP 30559 B (ISS)	On Orbit	
		Ext. pressure+ Mech. loads	1.4*(M)+max. P	1.10*(M)+max. P	1.10*M 1.0*P	NSTS14046 E	Liftoff	Liftoff mech. Loads (M) & Max. delta Pressure (P)
			1.4*(M)+max. P	1.10*(M)+max. P	1.10*M 1.0*P	NSTS14046 E	Landing	-Emergency Landing mech. Loads (M) & Max. delta pressure (P) -Normal landing TBD depending on whether Helium is present or not
			1.5*(M+ P)	1.1*(M+ P)		SSP 30559 B (ISS)	On Orbit	On Orbit mech. Loads (M) & Max. delta pressure (P)
		Internal pressure	1.10*MDP		1.0*MDP		Helium leak inside vacuum case (Failure case)	Positive delta pressure produces burst of outer cylinder

Notes:
1) MDP Highest pressure defined by max. relief pressure (Burst discs) at 0.8 atm.(11.76 psi)
2) Reference Appendix C for failure scenarios and credibility of failures. Note: No credible failure can be found that would create a positive pressure inside the VC
3) The internal pressure case is critical design case for buckling of the inner cylinder and the conical flanges.
4) Positive delta pressure is defined as the delta pressure when the pressure inside the vacuum case is higher than the outside pressure.

Table A1: USS-02, Cryomagnet, and Pressure Systems Factors of Safety (Cont.)

Item	Sub Component	Load Case	Factor of Safety		Proof Factor	Reference	Event	Comments
			Ultimate	Yield				
Magnet Vacuum Vessel	Upper and Lower Conical Flanges	External Pressure	1.5*MDP	1.10*MDP	1.0*MDP	MIL-STD-1522 A (Space Shuttle)	Liftoff/Landing Ground ops	Negative delta press. Collapses conical flanges
			2.0*DP	1.10*DP	1.5*DP	SSP30559 B (ISS)	On Orbit	DP is Max. Delta Pressure On-Orbit
		Mechanical loads	1.4	1.10	1.10	NSTS14046E (Space Shuttle)		
			1.5	1.10		SSP30559 B (ISS)	On Orbit	
		Ext. pressure + Mech. Loads	1.4*(M+max.P)	1.10*(M+max.P)	1.10*M 1.0*P		Liftoff	Liftoff Mech. Loads (M) & Max. Delta Pressure (P)
			1.4*(M+max.P)	1.10*(M+max.P)	1.10*M 1.0*P		Landing	-Emergency Landing Mech. Loads (M) & Max. Delta Pressure (P). -Normal Landing TBD depending on whether helium is present or not.
			1.5*(M+.P)	1.10*(M+.P)	1.10*M Orbit 1.0*P orbit	SSP 30559B	On Orbit	On Orbit mech. Loads (M) max. delta press. P
		Internal pressure	1.10*MDP		1.0*MDP		Helium leak inside vacuum case (Failure case)	Positive delta pressure produces buckling of conical flanges

Notes:
1) MDP Highest pressure defined by max. relief pressure (Burst discs) at 0.8 atm.(11.76 psi)
2) Reference Appendix C for failure scenarios and credibility of failures. Note: No credible failure can be found that would create a positive pressure inside the VC
3) The internal pressure case is critical design case for buckling of the inner cylinder and the conical flanges.
4) Positive delta pressure is defined as the delta pressure when the pressure inside the vacuum case is higher than the outside pressure.

Table A1: USS-02, Cryomagnet, and Pressure Systems Factors of Safety (Cont.)

Item	Sub Component	Load Case	Factor of Safety		Proof Factor	Reference	Event	Comments
			Ultimate	Yield				
Helium Vessel	Inner Cylinder	Internal Pressure	1.5*MDP		1.10*MDP	MIL-STD-1522 A (Space Shuttle)	Liftoff/Landing	Delta press. Produces Collapse on Vessel
			1.5*DP		1.10*DP	SSP 30559 B (ISS)	On Orbit	DP is max. delta press. On-orbit
		Mechanical loads	2.0	1.10	No static test	NSTS14046 E (Space Shuttle)	Liftoff/Landing	
			2.0	1.10	No static test	SSP 30559 B (ISS)	On Orbit	
		Int. pressure + Mech. Loads	2.0	1.10	No static test		Liftoff Ground Ops	(1 atm.+ Relief Valve Setting) Interntal Pressure and Zero Pressure in Vacuum Case
			2.0	1.10	No static test		Landing Ground Ops	1.0 atm. Ext. P and zero pressure in helium vessel
			2.0	1.10	No static test	SSP 30559 B (ISS)	On Orbit	
	Outer Cylinder & Upper and Lower Domes	Internal Pressure	1.5*MDP		1.10*MDP	MIL-STD-1522 A (Space Shuttle)	Liftoff/Landing	Positive delta press. Produces burst on vessel
			1.5*DP		1.10*DP	SSP 30559 B (ISS)	On Orbit	DP is max. delta press. On-Orbit
		Mechanical loads	2.0	1.10	No static test	NSTS14046 E (Space Shuttle)	Liftoff/Landing	
			2.0	1.10	No static test	SSP 30559 B (ISS)	On Orbit	
		Int. pressure + Mech. Loads	2.0	1.10	No static test		Liftoff Ground Ops	(1 atm.+ Relief Valve Setting) Internal Pressure & Zero Pressure in Vacuum Case
			2.0	1.10	No static test		Landing Ground Ops	1.0 atm. Ext. P And zero Pressure in Helium Vessel
			2.0	1.10	No static test	SSP 30559 B (ISS)	On Orbit	

Table A1: USS-02, Cryomagnet, and Pressure Systems Factors of Safety (Cont.)

Item	Sub Component	Load Case	Factor of Safety		Proof Factor	Reference	Event	Comments
			Ultimate	Yield				
Lines and Fittings	<1.5 inch dia.	Internal Pressure	4*MDP		1.5*MDP	NSTS1700.7B	All	Sect.208.4c
			4*MDP		1.5*MDP	SSP30559 B	All	Table 3.3.1-1
	>1.5 inch dia.	Internal Pressure	1.5*MDP		1.5*MDP	NSTS1700.7B	All	Sect.208.4c
			2.0*MDP		1.5*MDP	SSP30559 B	All	Table 3.3.1-1
Cryomagnet Suspension System		Mechanical Loads	1.4	1.2	1.2	NSTS14046 E	Liftoff/Landing	Test of Flight Components Including Temperature Corrections
Pressure System Components		Internal Pressure	2.5*MDP		1.5*MDP	NSTS1700.7B	All	Sect.208.4c
			2.5*MDP		1.5*MDP	SSP30559 B		Table 3.3.1-1
Unique Support Structure - 02		Mechanical	1.4	1.10	1.10	NSTS14046E	Liftoff/Landing	
			1.5	1.10	1.10	SSP30559 B	On Orbit	
Payload Attach System		Mechanical	2.0	1.1	No Test	SSP57003	Liftoff/Landing	
			1.5	1.1	1.5	SSP57003	On Orbit	
Magnet		Mechanical / Magnet Forces	1.5	1.10	1.10	NSTS14046E	Liftoff/Landing	
			1.5	1.10	1.10	SSP30559 B	On Orbit	

Notes:

1) Negative differential pressure on primary payload structure shall use a factor of safety of 2.0 if certification is by analysis **only**. (SSP 30559 B , sect 3.3.2.1.2)
2) Vacuum jackets shall have pressure relief capability to preclude rupture in the event of pressure container leakage.(NSTS 1700.7 B, sect.208.4b.3)
3) Proof test factor for each flight pressure container shall be a minimum of 1.1 times MDP. Qualification, burst and pressure cycle testing is **not** required if all requirements of para. 208.4, 208.4a and 208.4b are met. (Ref. NSTS 1700.7 b, sect 208.4b.6)
4) Analysis of buckling of thin walled shells shall use appropriate "knock down factors" as per NASA SP-8007 (Ref. SSP30559 B, sect. 3.5.2)
5) Thermal stresses/loads shall be combined with mechanical and pressure stresses/loads when they are additive but shall not be combined when they are relieving.(Ref. SSP30559 B, sect.3.5.1.2)
6) Factors of safety for external pressure have been assumed same as the F.S. for internal pressure but there is no reference for these in any of the documents.
7) Design loads for collapse shall be ultimate loads except that any load component that tends to alleviate buckling shall **not** be increased by the ultimate factor of safety.(Ref. SSP30559 B, sect 3.5.2)
8) Suspension system for helium vessel and magnet coils to be static tested 1.2* max. limit load and must be conducted on the flight article.

Table A2: AMS-02 Secondary Structures Factors of Safety

Item	Sub Component	Load Case	Factor of Safety		Static Test	Reference	Event	Comments
			Ultimate	Yield				
Secondary	Anti-Coincidence Counter	Mechanical loads	2.0	1.25	No	NSTS14046 E (Space Shuttle)	Liftoff/Landing	
			2.0	1.25	No	SSP 30559 B (ISS)	On Orbit	
	Tracker	Mechanical loads	2.0	1.25	No	NSTS14046 E (Space Shuttle)	Liftoff/Landing	
			2.0	1.25	No	SSP 30559 B (ISS)	On Orbit	
	Time of Flight	Mechanical loads	2.0	1.25	No	NSTS14046 E (Space Shuttle)	Liftoff/Landing	
			2.0	1.25	No	SSP 30559 B (ISS)	On Orbit	
	Low Energy Particle Shield	Mechanical loads	2.0	1.25	No	NSTS14046 E (Space Shuttle)	Liftoff/Landing	
			2.0	1.25	No	SSP 30559 B (ISS)	On Orbit	
	Transition Radiation Detector	Mechanical loads	2.0	1.25	No	NSTS14046 E (Space Shuttle)	Liftoff/Landing	
			2.0	1.25	No	SSP 30559 B (ISS)	On Orbit	
	TRD gas tubes	Pressure	2.0*DP	1.25*DP	1.2*DP	MIL-STD-1522A (Space Shuttle)	Liftoff/Landing Ground Ops.	1.0 atm. Inside, 1.0 atm. outside
			2.0*DP	1.25*DP	1.2*DP	SSP30559 (ISS)	On Orbit	1.0 atm. Inside, 0.0 atm. outside
	TRD gas Supply – Xe tank	Pressure	Reqt. - 1.5*MDP Actual – 3.1* MDP	1.10*MDP	1.5*MDP	MIL-STD-1522A (Space Shuttle)	Liftoff/Landing Ground Ops.	Xenon MDP 3000 psig.
			Reqt. - 2.0*MDP Actual – 3.1* MDP	1.10*MDP	1.5*MDP	SSP30559 (ISS)	On Orbit	

Table A2: AMS-02 Secondary Structures Factors of Safety (Cont.)

Item	Sub Component	Load Case	Factor of Safety		Static Test	Reference	Event	Comments
			Ultimate	Yield				
Secondary Structures (Contd.)	TRD gas Supply – CO_2/CF_4 tank	Pressure	Reqt. – 1.5*MDP Actual – 2.0* MDP	1.10*MDP	1.5*MDP	MIL-STD-1522A (Space Shuttle)	Liftoff/Landing Ground Ops.	CO_2/CF_4 MDP 3200 psig.
			Reqt. – 2.0*MDP Actual – 2.0* MDP	1.10*MDP	1.5*MDP	SSP30559 (ISS)	On Orbit	
	Electronic	Mechanical loads	2.0	1.25	No	NSTS14046 E (Space Shuttle)	Liftoff/Landing	
			2.0	1.25	No	SSP 30559 B (ISS)	On Orbit	
	Ring Imaging Cherenkov Counter	Mechanical Loads	2.0	1.25	No	NSTS14046 E (Space Shuttle)	Liftof/Landing	
			2.0	1.25	No	SSP 30559 B (ISS)	On Orbit	
	Electromagnetic Calorimeter	Mechanical Loads	2.0	1.25	No	NSTS14046 E (Space Shuttle)	Liftof/Landing	
			2.0	1.25	No	SSP 30559 B (ISS)	On Orbit	
	Synchrotron Radiation Detector	Mechanical Loads	2.0	1.25	No	NSTS14046 E (Space Shuttle)	Liftof/Landing	
			2.0	1.25	No	SSP 30559 B (ISS)	On Orbit	

Notes: 1) For test verified structures the ultimate factor of safety will be 1.40 for Space Shuttle and 1.50 for ISS and yield factor of safety will be 1.10 for Space shuttle and ISS.(Ref NSTS14046E and SSP30559B) (These factors of safety are tentative and have to be approved by the NASA Structures Working Group)

2) Pressure vessels shall be designed and fabricated under an approved fracture control program. (Ref. NASA-STD-5003 and SSP30558B)

3) The payload structure must be capable of supporting limit loads from all critical load conditions without detrimental deformation and ultimate loads without failure.

4) All FSs have been approved by SWG and EM2 [26].

Acronyms: DP Delta pressure

MDP Max. design pressure

AMS-02 Pressure System - Cryomagnet

Description	Volume (in^3)	Operating Pressure (psid)	MDP (psid)	MDP Determination	Burst Pressure (psid)	Burst SF	Proof Pressure (psid)	Proof SF	Expected On-Orbit Life (yrs)	Analysis Test or Similarity	Reference Document
Cryomagnet System	-	-	-		-	-	-	-			
SFHe Tank	152559	0.3	43.5	Ground Case - Worst case therma environment caused by complete loss of vacuum at STP	65.25	1.5	47.85	1.1	3	Test	MIL-STD-1522A SSP 30559B
Superfluid Cooling Loop Plumbing	TBD-Small	142*	>362.6	Ground Case - Worst case therma environment caused by complete loss of vacuum at STP	1450.4	4	543.9	1.5	3	Test	MIL-STD-1522A SSP 30559B
Cold Buffer Volume Container	TBD-Small	142*	>362.6	Ground Case - Worst case therma environment caused by complete loss of vacuum at STP	543.9	1.5	398.9	1.1	3	Test	NSTS 1700.7B
Warm Plumbing Lines (15 mm max) (Stainless/Copper/Aluminum)	TBD-Small	0.3	>362.6	Ground Case - Worst case therma environment caused by complete loss of vacuum at STP	TBD	>/= 4.0	TBD	>/= 1.5	3	Test	NSTS 1700.7B
Cold Plumbing Lines (15 mm max) (Stainless/Copper/Aluminum)	TBD-Small	0.3	>362.6	Ground Case - Worst case therma environment caused by complete loss of vacuum at STP	TBD	>/= 4.0	TBD	>/= 1.5	3	Test	NSTS 1700.7B
Temp/Pressure Gauges that are in Pressure System	-	TBD	TBD	TBD	TBD	TBD	TBD	TBD	3	Analysis	NSTS 1700.7B
Warm Valves (WEKA)	-	TBD	TBD	Ground Case - Worst case therma environment caused by complete loss of vacuum at STP	TBD	TBD	TBD	TBD	3	Test	NSTS 1700.7B
Cold Valves (WEKA), TMP, & PP	-	TBD	TBD	Ground Case - Worst case therma environment caused by complete loss of vacuum at STP	TBD	TBD	TBD	TBD	3	Test	NSTS 1700.7B
Warm He Tank	TBD	TBD	TBD	Worst case thermal environment for on-orbit operations	TBD	TBD	TBD	TBD	3+2 Cont.	Test	MIL-STD-1522A SSP 30559B
Warm Plumbing Lines (15mm max) (Stainless/Copper/Aluminum)	TBD Small	TBD	TBD	Worst case thermal environmet fo on-orbit operations	TBD	>= 4.0	TBD	>/= 1.5	3+2 Cont.	Test	NSTS 1700.7B
Warm Valves (WEKA)	-	TBD	TBD	Worst case thermal environmet fo on-orbit operations	TBD	TBD	TBD	TBD	3+2 Cont.	Test	NSTS 1700.7B
Vacuum Case	~140,000 effective volume	-14.7	11.8**	Ground Case - Worst case therma pressure environment caused by rupture of SFHe Tank into VC	17.7	1.5	11.8	1	3	Test	MIL-STD-1522A SSP 30559B

* Maximum during cool down phase Ground Operations

** This is a Vacuum Vessel and the MDP only applies in the event of contingency case

More details of the pressue systems and certification can be found in the AMS-02 SVP (JSC-28792A)
Cryocooler, Burst Disks, and other currently TBD items will be added to table for FSR Phase II.

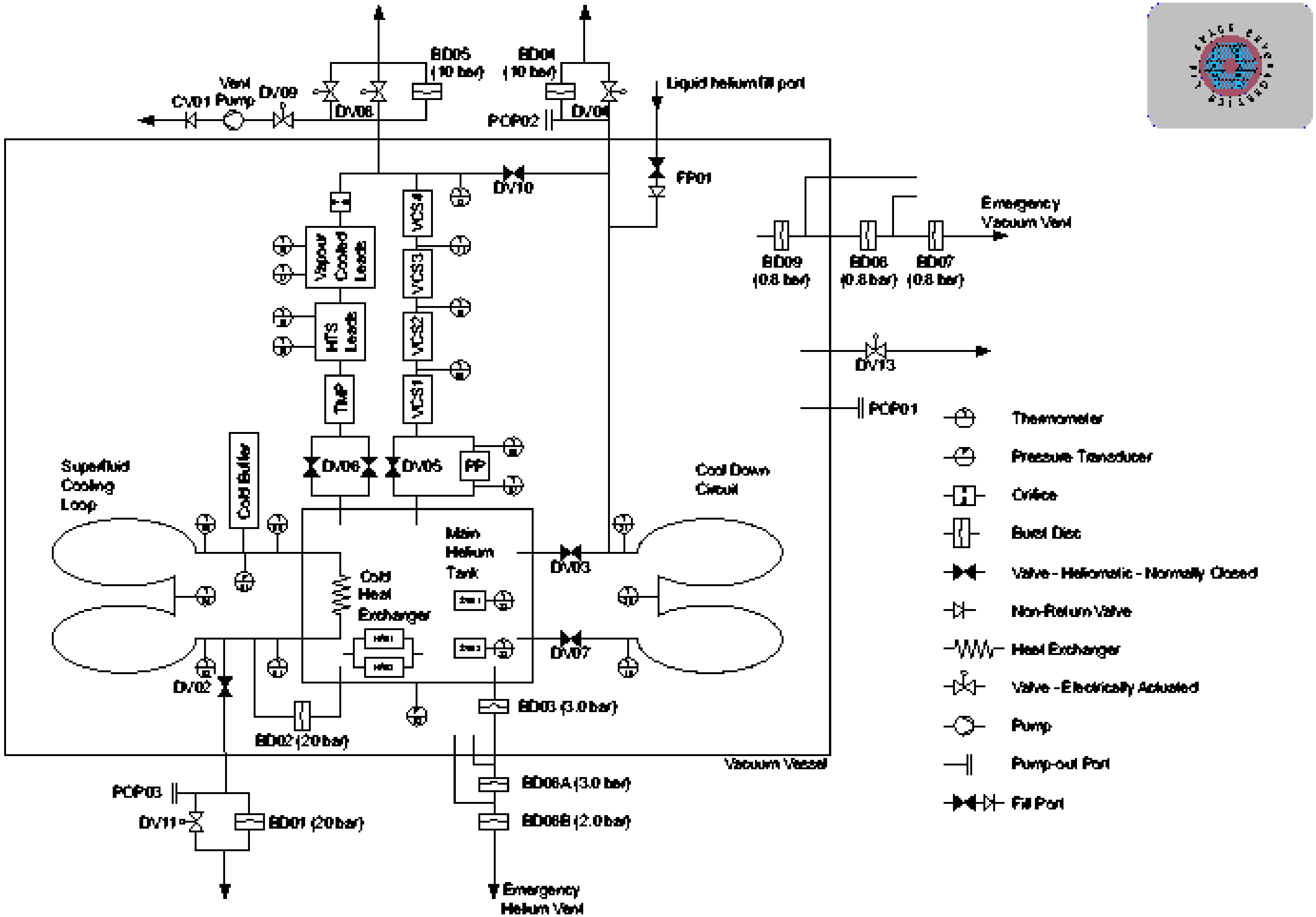
AMS-02 Pressure Systems – TRD Gas Supply

Description	Volume (in^3)	Operating Pressure (psid)	MDP (psid)	MDP Determination	Burst Pressure (psid)	Burst SF	Proof Pressure (psid)	Proof SF	Expected On-Orbit Life (yrs)	Analysis Test or Similarity	Reference Document
TRD Gas Supply System	-	-	-		-	-	-	-			
Xe Tank**	1,700	1550	3000	Worst case thermal enviroment for on-orbit operations	4500	1.5	9300	3.1	3+2 Cont.	Similarity & Test	MIL-STD-1522A SSP 30559B
CO2 Tank***	813	1740	3200	Worst case thermal enviroment for on-orbit operations	4800	1.5	6800	2	3+2 Cont.	Similarity & Test	MIL-STD-1522A SSP 30559B
Mixing Tank^	~122	60	TBD	Worst case thermal enviroment for on-orbit operations	TBD	1.5	TBD	>/=2.0	3+2 Cont.	Similarity & Test	MIL-STD-1522A SSP 30559B
TRD Straw Tubes	41 x 120*	14.7-20.4	29.4	Worst case thermal enviroment for on-orbit operations	44.1	1.5	>/=58.8	>/=2.0	3+2 Cont.	Test	NSTS 1700.7B
Plumbing Lines (3-6mm Stainless)	TBD-Small	1740 max	3200	Worst case thermal enviroment for on-orbit operations	>/=12800	>/=4.0	>/=4800	>/=1.5	3+2 Cont.	Test	NSTS 1700.7B

* There are 41 separate segments of TRD Tubes, each has a volume of 122 in^3
** Same Xe Tank design as for ISS Plasma Contactor Unit (PCU) (ARDE D4636), built and tested by ARDE, Inc.
*** Same as Tank built for X-33 (ARDE D4683), built and tested by ARDE, Inc.
^ Built and tested by ARDE, Inc.
Pressure Regulators used in system - Marotta RV29WA-6D
All tube connections are welded or metal sealed fittings.
Gas maniforlds and TRD segments connected with PEEK tubing and metal connectors.

More details of the pressue systems and certification can be found in the AMS-02 SVP (JSC-28792A)
Currently TBD hardware will be added to Table for FSR Phase II.

<u>The following schematic and document are for Hazard Reports AMS-02-3 & 4.</u>



Cryosystem Schematic

Alpha Magnetic Spectrometer - 02
Burst Disk Certification Approach
January 12, 2000
Trent Martin

The Alpha Magnetic Spectrometer – 02 (AMS-02) includes a large superconducting magnet that is being built by Space Cryomagnetics Limited (SCL) of Oxford, England. The cryogenic system on AMS-02 employs numerous burst disks. AMS-02 will certify these burst disk to meet NSTS-JSC, TAA-88-074 (October 18, 1988) entitled 'Fault Tolerance of Systems Using Specially Certified Burst Disks.'

The current burst disk design that AMS-02 intends to use is a reverse acting – circumferentially scored design with cutting teeth to provide a redundant burst method (see Figure 1 below). TAA-88-074 details 4 criteria that must be met by the proposed burst disk design:

a) **The design does not employ sliding parts or surfaces subject to friction and/or galling. In addition, special attention shall be given to the use of stress corrosion resistant materials, particularly in parts under continuous load such as Bellville springs.**

The proposed design does not employ sliding parts or Bellville springs.

b) **The design used must be qualified for the intended application by test data applicable to meet temperature and flow rate.**

AMS-02 will design and build a special test flow rig that will allow both the peak flow rate and the flight temperatures to be characterized for burst disk testing.

c) **Qualification must be for the specific part number used, and it must be verified that no design or material changes exist between flight assemblies and assemblies making up the data base.**

The burst disk supplier will have the correct quality assurance procedures in place to certify the integrity of the manufacturing process. Certification letters will accompany each burst disk lot, and testing will be performed for each specific part number.

d) **Each flight assembly shall be verified for membrane actuation pressure by use of special tooling or a procedure to prevent cutting edge contact during the test. If this is not feasible, demonstration of good materials and processes control and a rigorous lot screening program approved by the NSTS Payload Safety Review Panel are required.**

TAA-88-074 states 'The preferred burst disk design for payloads is one which employs a reversing membrane against a cutting edge to assure rupture. Historical use and experience indicate that a burst disk of this type can be certified as a highly reliable pressure relief device. When a burst disk of this type is used as the second and final control of pressure, the two fault tolerant requirement may be assessed as having been met if the burst disk.' The burst disk design that AMS-02 found that exactly meets this statement is shown in Figure 2. It was suggested to AMS-02 that the reason that this burst disk design was originally chosen was because the actual flight burst disk could be checked to ensure that it would relieve at the proper pressure. AMS-02 believes there to be some risk involved with testing the actual flight disks if they are of the design shown in Figure 2. If the blades are removed and the disk is allowed to pop over are the set pressure, then the blades may not be reattached correctly, or more importantly the material properties of the dome may be altered. AMS-02 also believes this design to be incompatible with disks with genuine redundancy.

AMS-02, instead recommends the design shown in Figure 1. This design is truly redundant because the burst disk is design to open along the scored line. If the burst disk fails to open along the scoring, then the teeth act to initiate a tear along the scored line. Since the actual flight burst disks can not be tested in this design, AMS-02 recommends a rigorous lot testing plan. British Standard 2915, that is typically used by the burst disk manufacturer, recommends testing of 2 disks out of a lot of 10. AMS-02 will test 8 out of 10 disks. It is anticipated that each test will take as much as two weeks, but the added safety factor is extremely important.

In addition to the proposed testing, the burst disk manufacturer has a database of information on this type of burst disk design. By applying statistical analysis to demonstrate certainty to an acceptable level that the flight disks will operate within a given rage of burst pressures. The MDP associated with that burst disk will use the upper limit of this range. This is the same technique that the burst disk manufacturer has used in the past for the European Space Agency for an Ariane Rocket fuel system.

Information will be added for FSR phase II to show demonstration of good materials and process controls.

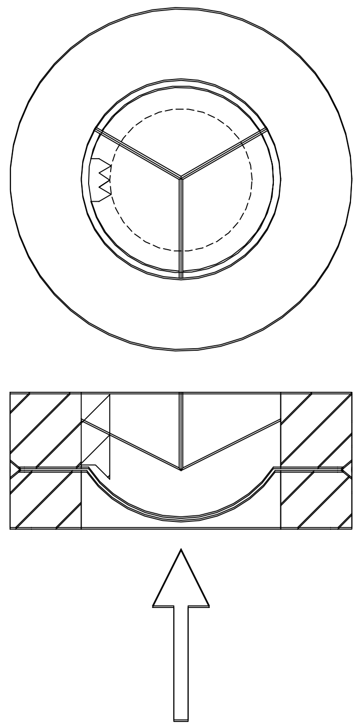


Figure 1: Reverse Acting Circumferentially Scored with Cutting Teeth Burst Disk Design

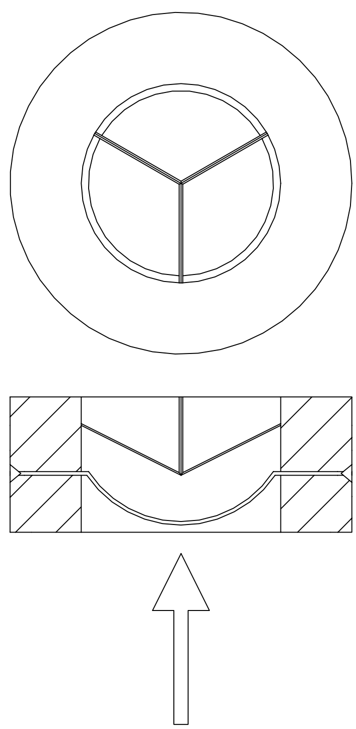


Figure 2: Reverse Acting Bladed Burst Disk Design

<u>The following presentation pages are for Hazard Reports AMS-02-3 & 5.</u>

Alpha Magnetic Spectrometer (AMS-02)

Meteoroid and Orbital Debris (M/OD) Risk Assessment

(Assessment 6.2 – 1996 Debris Environment Assessment)

AMS-02 M/OD Risk Assessment Objectives

The current AMS-02 meteoroid and orbital debris (M/OD) risk assessment objectives are:

- Update the AMS-02 finite element model to include the most recent physical changes including changes to M/OD shields, TRD case, Helium Case, avionics cases, and calorimeter
- Update the vacuum case finite element model to include varying wall thickness information
- Change the analysis period to start on October 15, 2003
- Change the vacuum case analysis period to be 3.0 years. All other pressure vessels are 5.0 years
- Update the BUMPER-II code to include a new ballistic limit equation for the vacuum case with thermal blanket

P R E L I M I N A R Y

AMS-02 M/OD Risk Assessment Failure Criteria

For **on-station assessments** the failure criteria are:

Vacuum Case Failure: penetration of the vacuum case outer wall and penetration of the Helium tank (critical)

Transition Radiation Detector (TRD) Case Failure: penetration of the TRD case and penetration of the TRD tank Nextel™ covering, aluminum M/OD layer, and the Kevlar™ layer (critical)

Helium Case Failure: penetration of the Helium case (critical)

Electronics Crate Failure: complete penetration of any of the electronics crate cases (functional)

For **in-transit (in orbiter payload bay) assessments** the failure criteria are:

Vacuum Case Failure: penetration of the vacuum case outer wall (functional)

PRELIMINARY

AMS-02 M/OD Risk Assessment Results Summary

Alpha Magnetic Spectrometer (AMS-02) Meteoroid & Orbital Debris Risk Assessment		
AMS-02 Critical Region	Probability of Non-Penetration by Both Particles	Odds of Penetration by M/OD Particle
Penetration of Vacuum Case & Helium Tank	0.99805	1 in 512
Penetration of TRD Tank	0.99997	1 in 32258
Penetration of Warm Helium Tank	0.99999	1 in 123457
Combined Penetration of Vacuum Case and TRD	**0.99801**	**1 in 502**

AMS-02 Probability of Non-Penetration Tentative Requirement [1]	0.997	1 in 333

Table 1 - AMS-02 M/OD Risk Assessment Results Summary – 5 year exposure (3 year exposure for vacuum case)

PRELIMINARY

AMS-02 M/OD Risk Assessment Assumptions

1. Launch on flight UF-4, *15-Oct-2003* [2003.789])
2. Return 15-Oct-2007.789 (exposure 5.000 years)
3. AMS-02 installed on S3 ITS inboard upper Payload Attach System
4. AMS-02 tilted toward port 12 degrees to accommodate adjacent payload.
5. Altitude is 400 km constant.
6. Attitude is based on the average of station TEAs during assembly flights within that stage time period. Attitudes are based on B321 (ypr) sequence.
7. Attitude is constant at (roll, pitch, yaw) = (0.7, -10.4, -5.8)
8. Orbit inclination is 51.6 degrees.
9. Solar flux is based on TM-104825
10. Constant debris density was assumed at 2.8 g/cm^3
11. Meteoroid particle density distribution based on SSP-30425
12. Debris environment model based on TM-104825 (1996 environment)
13. Meteoroid environment model based on SSP-30425
14. Analysis code BUMPER-II version 1.80 (09/20/00)

Table 2 - AMS-02 M/OD Risk Assessment input parameters and assumptions

<u>The following presentation and report are for Hazard Report AMS-02-4.</u>

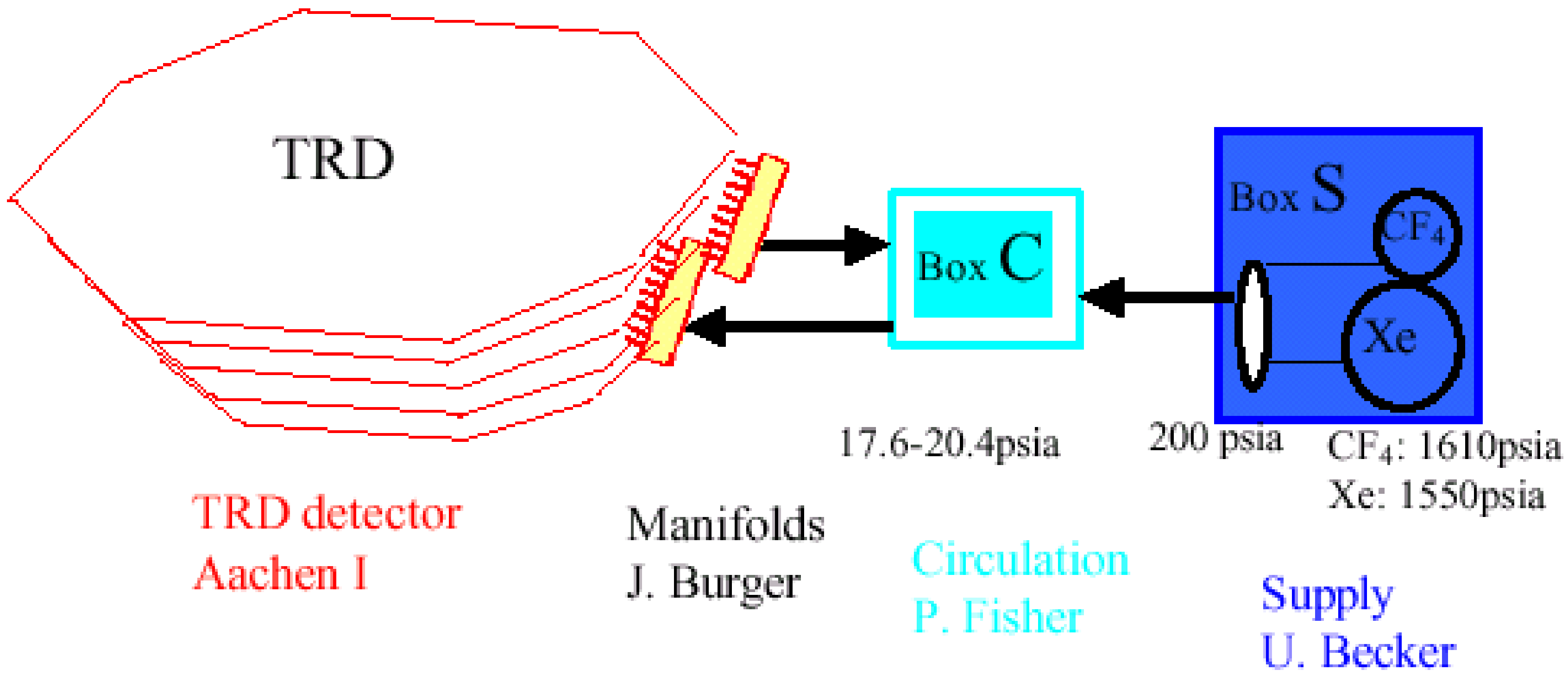
Double Click on Icon to View

"Cryosystem Venting & Cert.ppt"

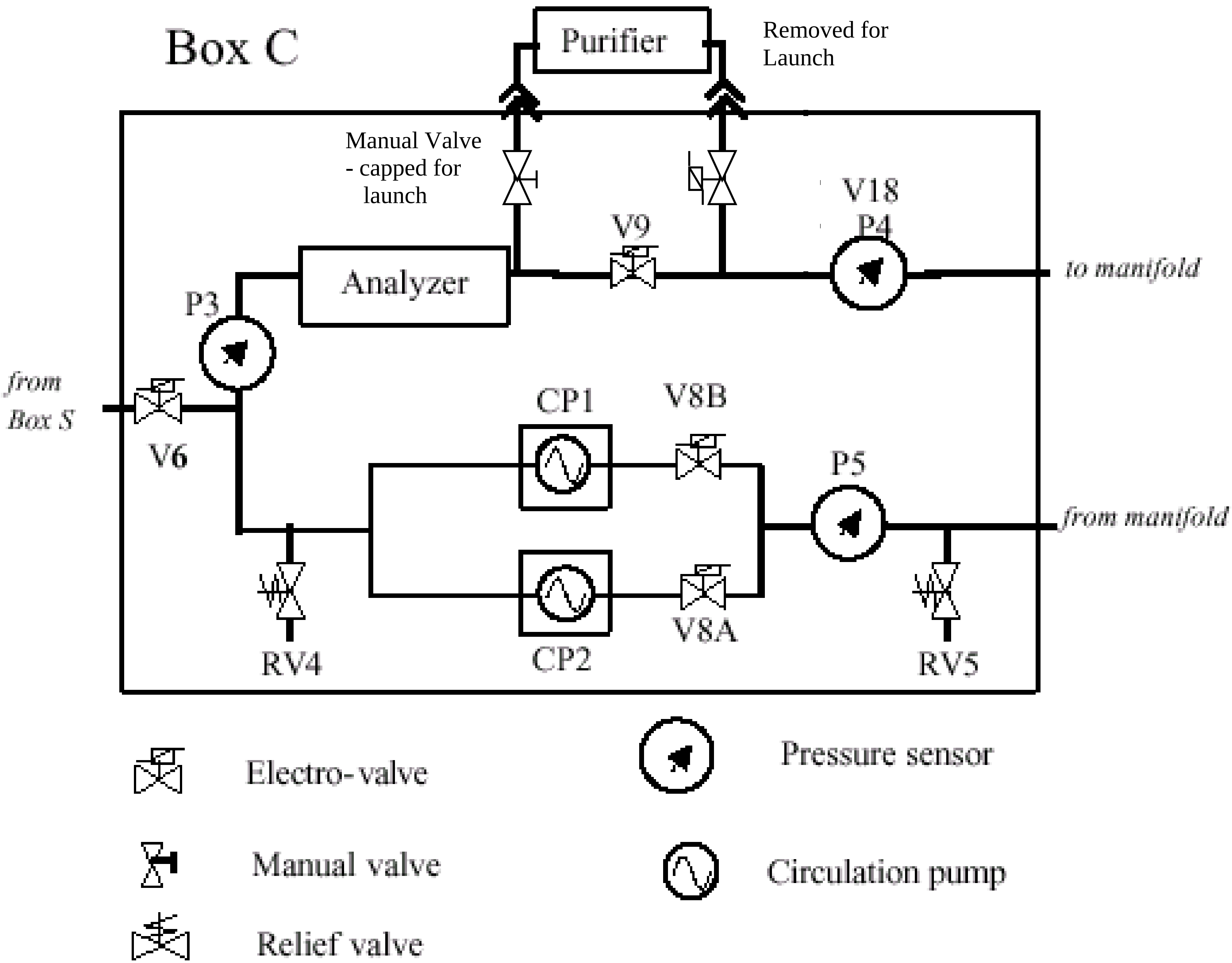
Double Click on Icon to View

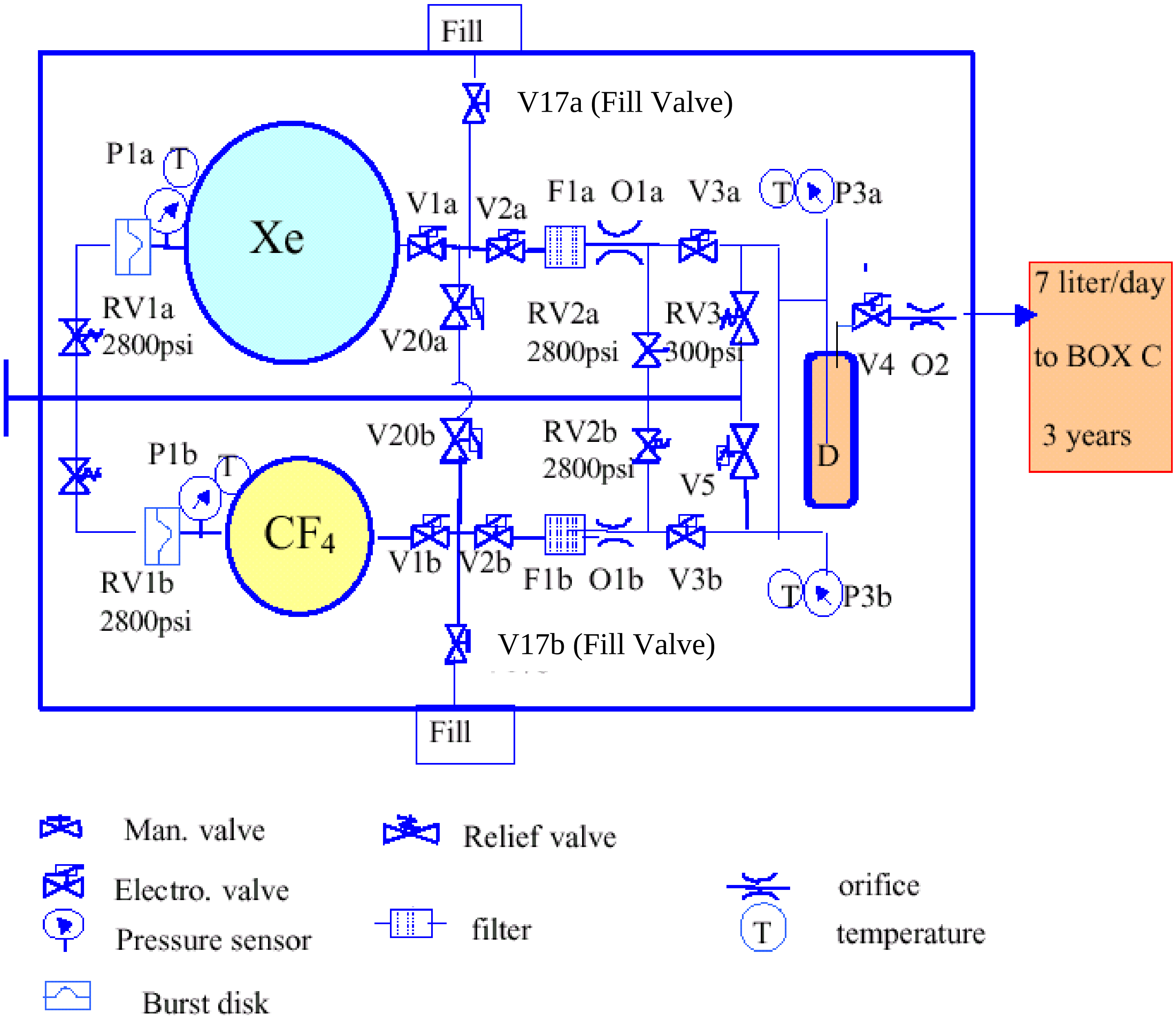
"Venting Analysis.PDF"

The following figures are for Hazard Report AMS-02-5.



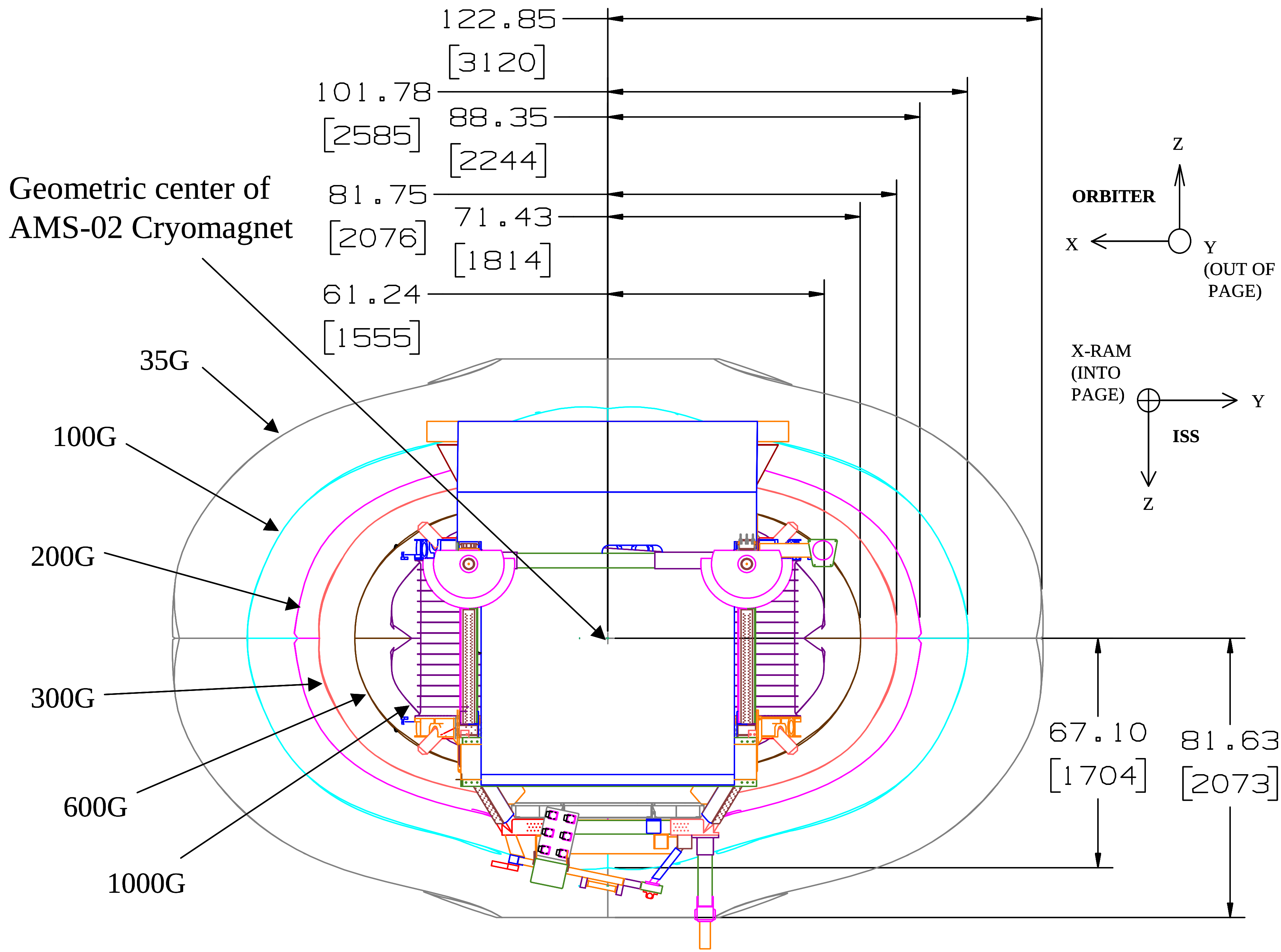
Schematic Arrangement of the AMS-TRD gas system.
All pressures are given at 25 C.


Box C
Purifier
Removed for
Launch
Manual Valve
- capped for
launch
V18
V9
P4
Analyzer
to manifold
P3
from
Box S
V6
CP1
V8B
P5
from manifold
RV4
CP2
V8A
RV5
Electro-valve
Pressure sensor
Manual valve
Circulation pump
Relief valve



pressures, normal	**Xe (25^{0}C) 1550 psia**	**CF_4(25^{0}C) 1610 psia**
Vessel rated at:	**Xe (65^{0}C) 3000 psia**	**CF_4(65^{0}C) 3200 psia**

The following presentation pages are for Hazard Report AMS-02-7.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[2076]
71.43
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61.24
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Geometric center of
AMS-02 Cryomagnet
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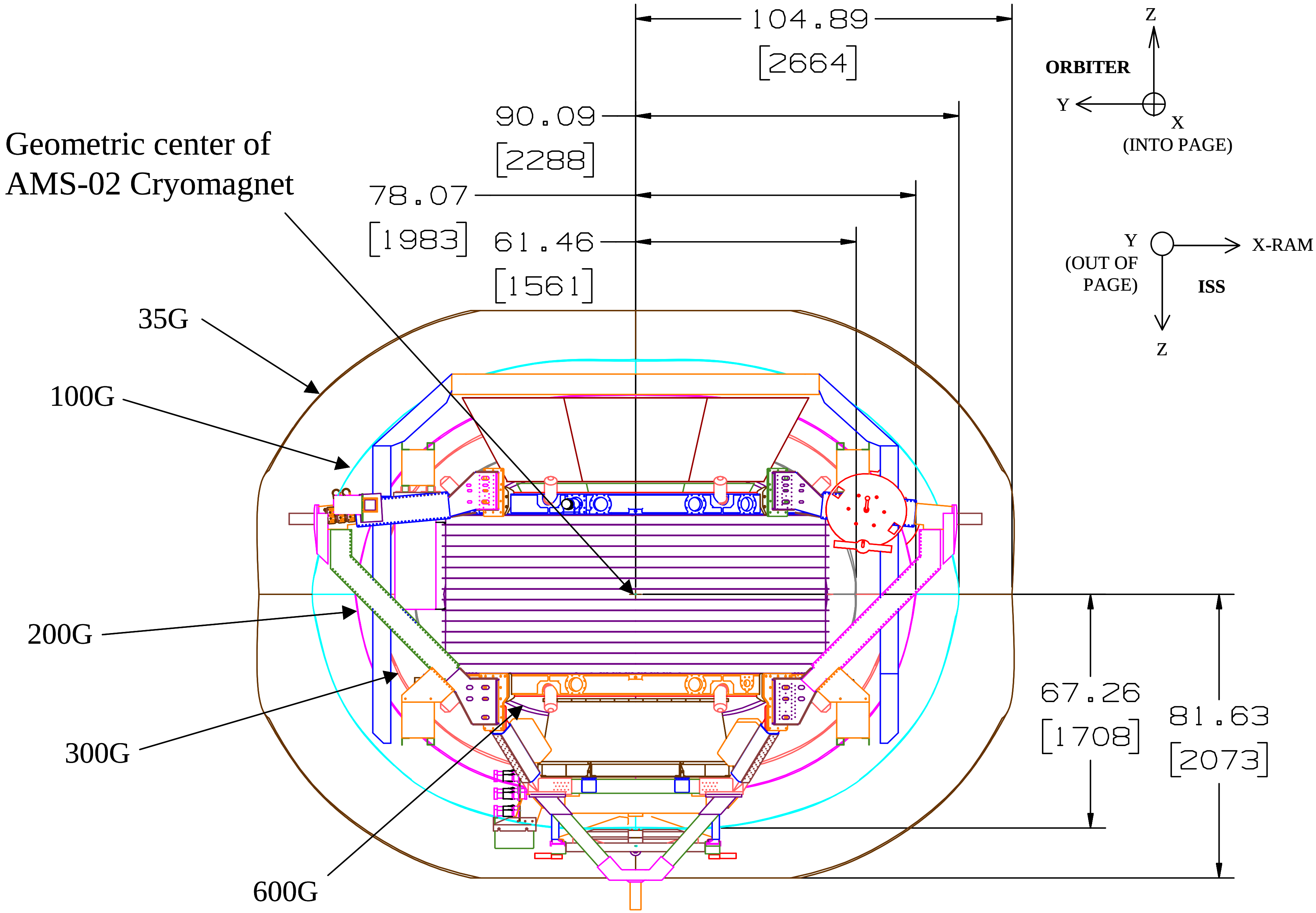

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78.07
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Geometric center of
AMS-02 Cryomagnet
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PAGE)
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100G
200G
300G
600G
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[1708]
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[2073]

JSC Form 44 and Figure 1 are for Hazard Report AMS-02-9.

IONIZING RADIATION SOURCE DATA SHEET
SPACE FLIGHT HARDWARE AND APPLICATIONS

Lyndon B. Johnson Space Center

Complete Items 1 through 10 and Part A for radioisotope sources and Part B for ionizing radiation-producing equipment.

IDENTIFICATION

1. PAYLOAD DESIGNATION/EXPERIMENT AMS-02	2. STS NUMBER AND/OR LAUNCH DATE UF-4
3. SOURCE USING ORGANIZATION M.I.T.	4. ADDRESS 77 Massachusetts Av., Cambridge MA 02138-4307
5. CONTACT Joseph Burger EP Division CERN, CH1211 Geneva 23,	6. TELEPHONE 41 79 2010241
7. PAYLOAD SPONSOR/MANAGER Mission Management Office/JSC	8. ADDRESS Mail Code SF3 2101, NASA Road 1, HOUSTON TX 77058
9. CONTACT James R. Bates	10. TELEPHONE 1 281 483 0657

PART A. RADIOISOTOPE SOURCES

I. SOURCE DESCRIPTION

ISOTOPE	TOTAL QUANTITY *(MILLICURIE)* *(Include determination date)*	NUMBER OF SOURCES *(List individual source quantity)*
Fe^{55}	Less than 0.0008 mCi (4×0.0002mCi)	2 to 4, each ≤ 1.9kBq (e.g. 2 to 4 sources of 0.2μCi (1.85kBq))

CHEMICAL FORM Solid Iron Citrate	PHYSICAL STATE Solid encapsulated
SOURCE SEALED ☒ YES ☐ NO	IDENTIFICATION NUMBERS
MANUFACTURER e.g. MIT radiation lab or Isotope Production Laboratories	ADDRESS 77 Massachusetts Av., Cambridge MA 02139 1800 N. Keystone St., Burbank CA 91504

II. SOURCE USE DATA

PURPOSE

- ☐ EXTERNAL CALIBRATION
- ☒ INFLIGHT CALIBRATION
- ☐ OTHER *(Describe)*
- ☐ CREW INVOLVEMENT/REQUIREMENTS *(Include nominal and contingent situations)*

III. SOURCE DIAGRAM

DETAILS ON SEALING, TECHNIQUES, AND DIMENSIONS

See attached figure and description, “Gas Monitoring Tubes”.
Fig. 1 shows the construction of a monitor tube containing a Fe^{55} source.

IV. TEST DATA

DATA SOURCE LEAK TESTED	RESULTS (MICROCURIE)
Will be done after manufacture.	Expected to be 0.

THERMO-VACUUM QUALIFIED TO:	DATE
____________ MM Hg ____________ DEGREE C.	

V. PRE-FLIGHT TRANSFERS

LOCATIONS WHERE SOURCE IS TO BE USED OR STORED AND APPROXIMATE DATES

LOCATIONS	DATED FROM:	TO:
MMPF /SSPF	08/2003	01/2004
STS/ISS	01/2004	02/2004

SOURCE CUSTODIAN/RADIATION SAFETY OFFICER	TELEPHONE
Joseph Burger	+41 79 2010241

VI. POST-FLIGHT DISPOSITION

OUTLINE REQUIREMENTS

The sources will remain installed internally in AMS-02 through shipment from KSC back to ETH Zurich.

PART B. IONIZING RADIATION PRODUCING EQUIPMENT

I. EQUIPMENT CHARACTERISTICS

TYPE OF RADIATION PRODUCED

MAXIMUM ENERGY LEVEL	OPERATING ENERGY LEVEL

DURATION OF OPERATION	NO. OF UNITS	PULSED UNIT DUTY CYCLE
________ HOURS TOTAL, ALL UNITS		

II. RADIATION CHARACTERISTICS

RADIATION INTENSITY OF FLIGHT CONFIGURED UNIT	SECONDARY RADIATIONS PRODUCED: ENERGY LEVEL	SECONDARY RADIATIONS PRODUCED: TYPE
________ RAD/HR @ ________ METERS	________ KeV	

III. EQUIPMENT USE DATA

CREW INVOLVEMENT/PROCEDURES

No crew involvement. Sources are installed internally in AMS-02.

RADIATION PRODUCTION WARNING SYSTEM	SAFETY INTERLOCK SYSTEM
☐ YES *(Describe)* ☐ NO	☐ YES *(Describe)* ☐ NO

Gas Monitoring Tubes

Mounted in Box C or Box S are 2 to 4 calibration tubes, which monitor the gas gain changes for locally different temperatures. The calibration tubes have an id of 6mm like the straw tubes, however are mounted inside a stainless steel container, Fig. 1. On the inner wall is a 0.2μCi deposit of Fe^{55}. The 1mm wall attenuates the 5.9keV radiation to a level less than detectable. The outer stainless steel container seals in the radiation again and supplies the gas for calibration.

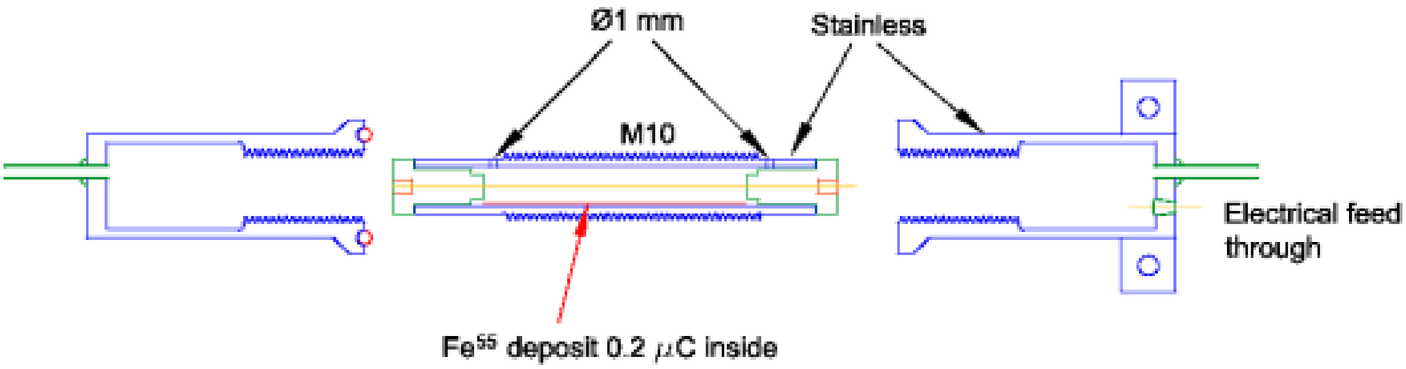
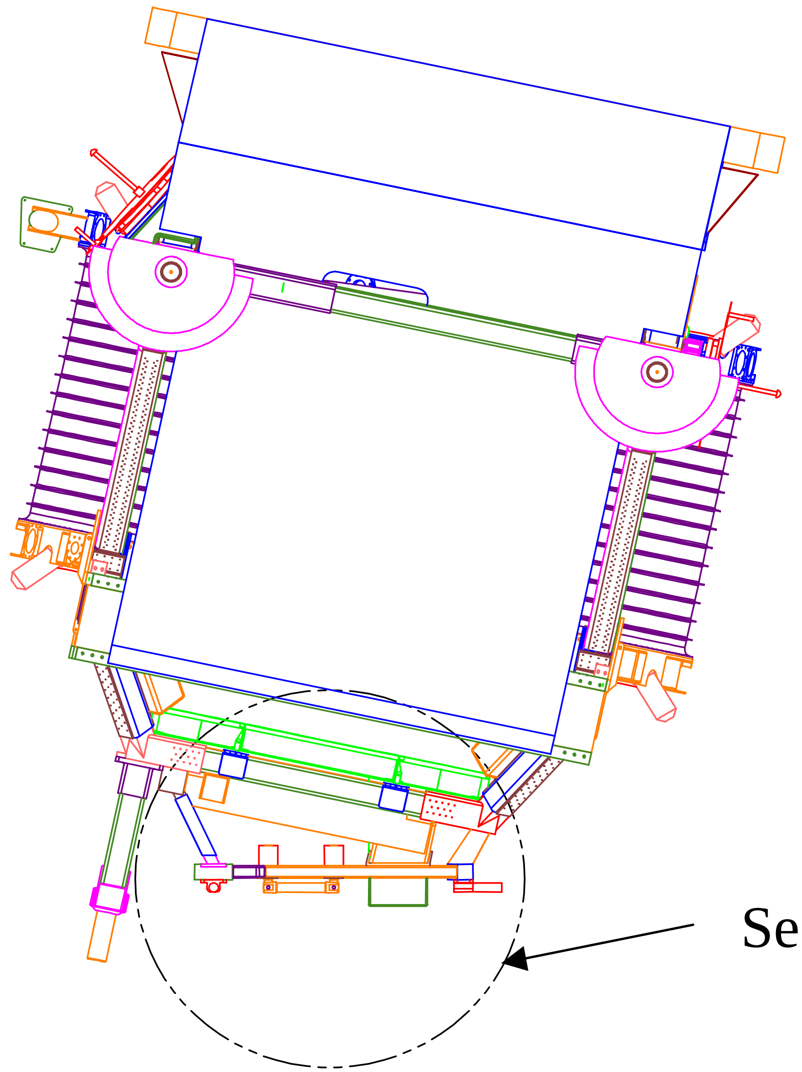
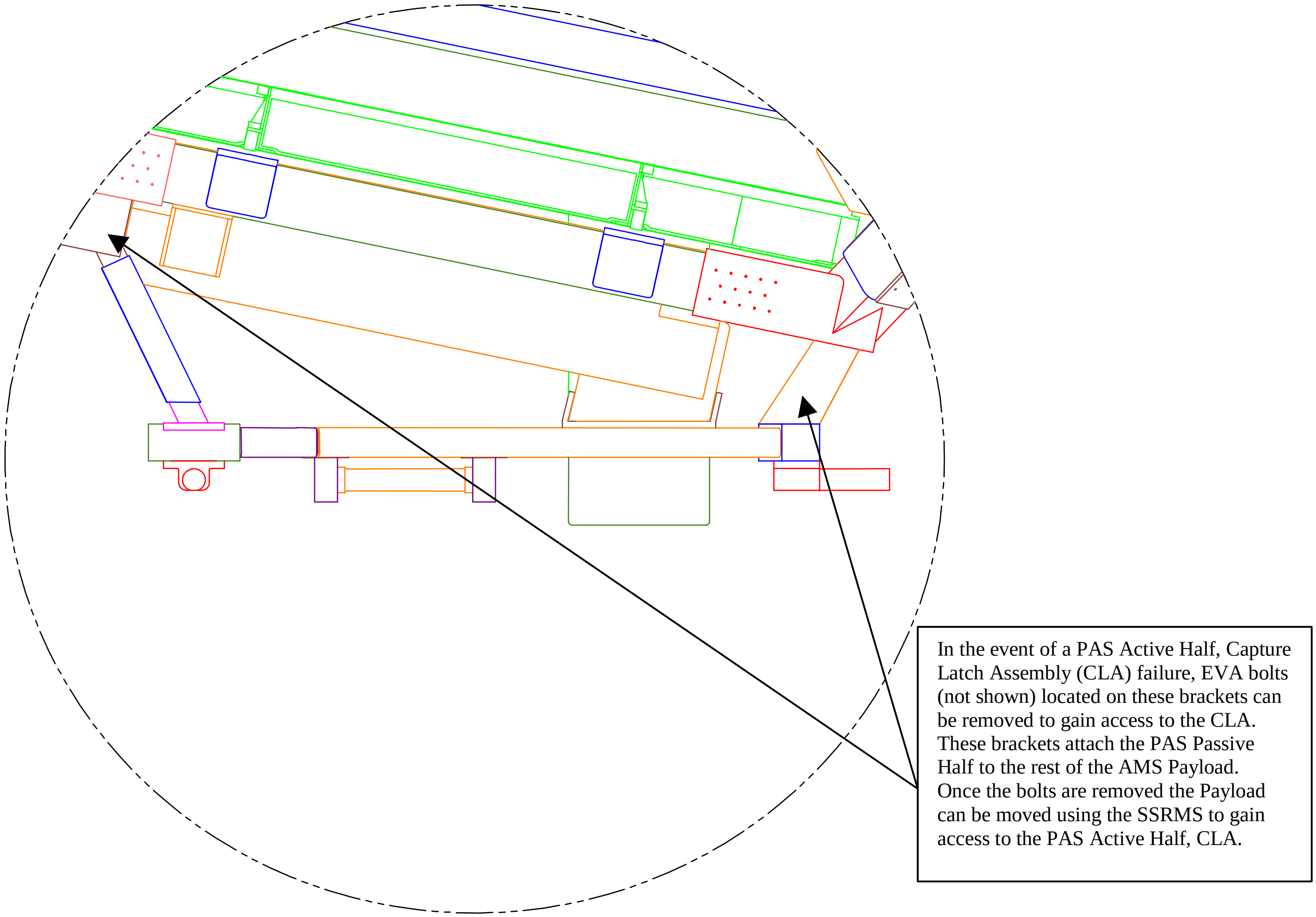


Figure 1 – Calibration Tube with Doubly Contained Weak Source

<u>The following Figures are for Hazard Report AMS-02-11.</u>



See Detail A



Detail A – No-Spring Design (with rigidly attached capture bar)
-Design of capture bar is TBD Based on ISS Requirement Changes